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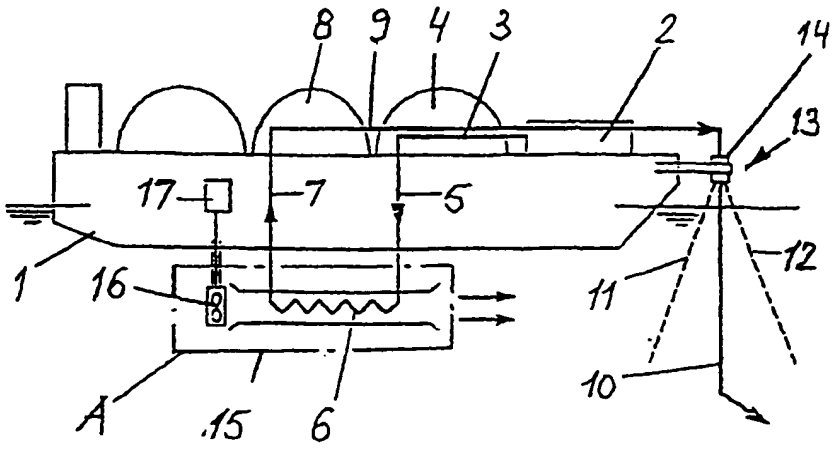
(54) Title: DEVICE FOR EVAPORATION OF LIQUEFIED NATURAL GAS



(57) Abstract: A device for evaporation of liquefied natural gas (LNG) on board a vessel (1). The device comprises a pipeline (6) through which LNG flows. The outside of the pipeline (6) may be brought in contact with a heating medium, for example seawater. According to the invention the pipeline (6) is immersed in the sea and is connected to the vessel (1). The pipeline (6) is enclosed by a shell (15) through which seawater is pumped by means of a pump (16), which is operated by a motor (17) on board the vessel.

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Device for Evaporation of Liquefiel Natural Gas.

The invention relates to a device for vaporising liquefied natural gas (LNG) onboard a ship, comprising at least one pipeline, through which LNG flows, whereby an outside of the pipe may be brought in contact with a heating medium, for example seawater.

A device of this type is presently used at onshore receiving terminals for LNG located near a quay or jetty, where the vaporised gas, hereafter referred to as NG, is transported to the consumer via a pipeline system.

Such receiving terminals may comprise insulated tanks for receiving LNG from the vessel, a vaporiser or heat exchanger for vaporisation of LNG, and a control -and metering module for adjustment and metering of the gas which is passed to the consumer pipelines.

The known vaporiser comprises pipes, which is sprinkled with seawater. The heat energy of the seawater is transferred to the LNG located inside the pipe, which causes heating of the LNG that in turn leads to evaporation and superheating of the LNG towards ambient temperature. The difference in temperature between LNG and vaporised/super heated gas is approximately 170-180°C. Maximum energy transfer from the seawater corresponds to a temperature reduction of 5-8°C. The flow rate of circulating seawater therefore has to be significantly larger than the flow rate of LNG/NG, which is vaporised and overheated. The seawater is taken from the sea in the vicinity of the terminal and is returned to an area as far from the inlet as necessary to prevent mixing and short-circuiting.

Several disadvantages are related to the known vaporiser.

Due to the small temperature difference available, the seawater volume has to be disproportionately large. This leads to high power requirements to run the circulation pumps and therefore to a low energy efficient process.

Long inlet and outlet pipes with large diameters are required for supply and return of the seawater to a location at large depth in the sea in order to prevent detrimental environmental consequences for the shore zone. This increases the requirement for large pumps and results in long pipelines.

In addition, strainers and devices for prevention of clogging and fouling inside the pipes are required.

To protect the seashore long pipelines with large diameters are also required onshore.

Devices of the known type therefore occupy a large area and are expensive to install and operate.

The objective of the invention is to provide a device of the above-mentioned type, but which does not include the mentioned disadvantages.

The objective of the invention is fulfilled by a device according to the claim.

The invention will be described below with reference to the drawings. The drawings show a system according to the invention.

FIG. 1 is a schematic side elevation showing a floating vessel, which carries a device according to the invention.

FIG. 2 is an enlarged sketch of the section, which in fig.1 is designated A

FIG. 3 shows a sketch of a vessel and a pipe arranged as a helical coil immersed in the water beneath the vessel.

A vessel 1 which may be anchored near a jetty (not shown) or moored to it, comprises a control -and metering device 2, for receiving LNG which is pumped from the supply ship (not shown), and for discharging NG to the consumer pipe network pipelines (not shown) onshore.

From the control –and metering device 2 a line 3 is extending to a tank 4, in which the LNG is stored, and from tank 4, a pipe 5 leads to one end of a pipe or pipe device 6, which is immersed in the sea beneath the vessel 1, and which acts as a vaporiser. From the other end of pipe 6, a pipe 7 leads to for example a storage tank 8 for NG, and from this tank 8 a pipe 9 leads to the regulator and metering device 2. From the control -and metering device 2, a pipe 10 is leading to one or more consumers of NG, for example via a consumer pipe network system onshore (not shown). The vessel may be moored by means of anchor chains, 11, 12 which are connected, to the vessel at a location 13. At said location 13 a swivel 14 may be arranged for the anchor chains 11, 12 and the line 10, so that the vessel may rotate around this point, for example under the influence of wind without twisting of anchor cables and the pipe.

A tubular shell 15 may enclose the pipe 6. A propeller 16 which may be operated by means of a motor 17 on board the vessel 1, is arranged at an end of the shell 15, which faces away from the mooring cables 11, 12. By operating the propeller 16, seawater is forced through the casing 15 and around the pipe 6 in a direction towards the mooring cables 11, 12. In this manner the propeller provides a current of relatively warm seawater around the pipe 6 causing evaporation of LNG, and at the same time provides a thrust on the vessel 1 away from the mooring cables 11, 12, holding them tight and straight.

The shown device functions as follows.

From a ship transporting the LNG and which has been moored close to the vessel 1, a pipe (not shown) is being connected to the control –and metering device 2. Subsequently LNG is pumped from the ship to the LNG tanks 4 of the vessel, from where LNG may be pumped to the pipe or pipe device 6. This is of sufficient length that all LNG which is introduced at the inlet has been evaporated to NG at the pipe exit. This evaporation is caused by seawater, which is forced through the shell by means of the propeller 16 and transfers a part of its heat energy and is thereby reduced in temperature.

The produced NG is subsequently transported to the tank 8 used for storing of NG, from where NG is further transported to the control -and metering device 2. The amount, which is to be supplied to the consumer pipe network via line 10, is at this point measured and metered.

Typical seawater temperature at the inlet of the shell may be 15 °C, and at the shell exit approximately 5°C.

It is to be understood that by arranging the evaporating pipe or evaporating system 6 near the vessel 1, there is no need for long pipelines, which is the case for the known technique. It is further to be understood that even if it is preferred that a casing 15 and a propeller 16 are mounted, the system may be also function without these features, depending on the size of the plant, it's capacity and arrangement. It is further to be understood that the plant may function without the collecting tanks 4 respectively 8, as LNG and NG may be pumped directly to and from the pipe 6 via the control - and metering device 2. It is also to be understood that the power requirement for pumping of LNG through this vaporiser is considerably less than the power requirement of a traditional evaporator as described above. Investment costs

as well as operating costs are therefore considerably less than traditional vaporising installations. There are also far less environmental effects.

Fig. 2 is an enlarged sketch of the section, which in fig.1 is designated A. It is shown that a pipe arrangement 6 of the vaporiser may comprise a series of single pipes 18 that pass between a inlet manifold 19 and an outlet manifold 20.

Fig. 3 shows an anchored vessel 21, that is connected to a pipe 26, which is placed in the water beneath or near the vessel 21. The function of the pipe 26 corresponds to the function of the pipe 6, and the pipe 26 may be connected to the vessel in the same way as the pipe 6 is connected to the vessel 1. The pipe 26 is however helical and mainly in one plane, lying at the seabed. Alternatively the pipe 26 may be arranged to float in the sea at a wanted depth by means of floaters or lines that are connected to the vessel, and to be fastened to the seabed by means of anchoring arrangement.

PATENT CLAIM:

1. A device for evaporation of liquefied natural gas (LNG) on board a vessel, comprising at least one pipeline through which LNG flows, of which outside of said pipeline may be brought in contact with a heating medium, for example sea water, characterised by a pipe (6) which is immersed in the sea, possibly to the seabed and connected to the vessel, of which pipe is enclosed by a tubular shell (15) through which said shell sea water is pumped by means of a propeller or the like (16) which is operated by a motor installed on board the vessel.

Fig. 1

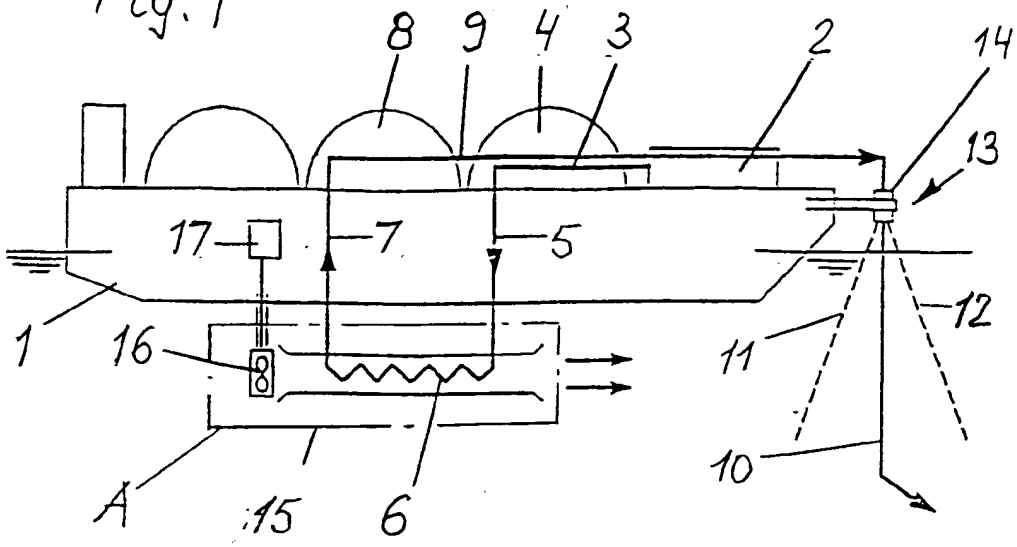


Fig. 2

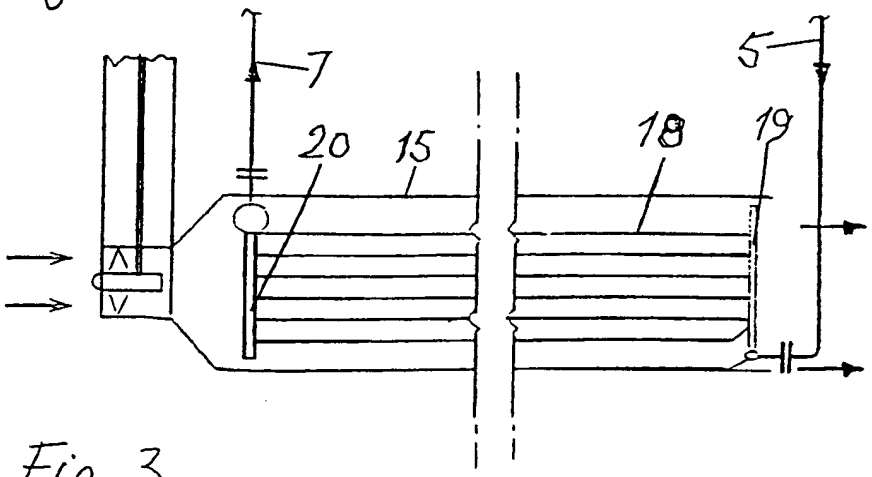
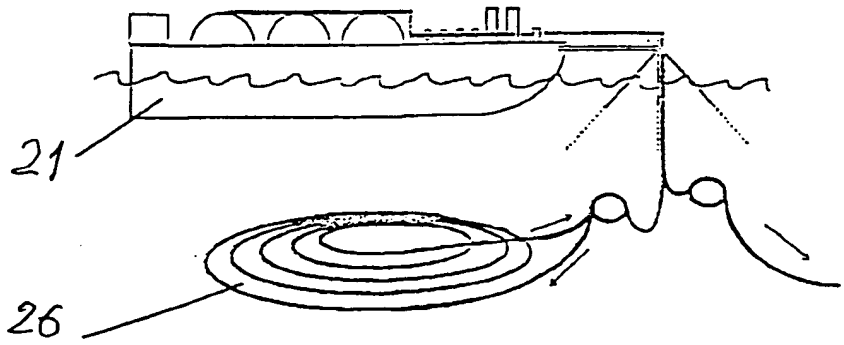


Fig. 3



INTERNATIONAL SEARCH REPORT

International application No.
PCT/NO 00/00234

A. CLASSIFICATION OF SUBJECT MATTER

IPC7: B01D 1/00, F17C 9/02, B63B 35/00
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC7: F17C, B01D, B63B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

SE,DK,FI,NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 3986340 A (HENRY W. BIVINS, JR.), 19 October 1976 (19.10.76), abstract ---	1
A	US 3266261 A (J.H. ANDERSON), 27 November 1964 (27.11.64), abstract --- --------	1

☐ Further documents are listed in the continuation of Box C. ☒ See patent family annex.

* Special categories of cited documents:
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"X" document of particular relevance: the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
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Date of the actual completion of the international search	Date of mailing of the international search report
18 December 2000	20 -12- 2000
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